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Complications of Anterior Skull Base Surgery

Abstract—The complications associated with anterior skull base surgery were reviewed in 49 consecutive patients treated between November 1986 and August 1993. All procedures involved a combined otolaryngologic and neurosurgical approach, and the senior otolaryngologist was the same. Fifty-two procedures were completed; 37 for malignant disease and 15 for benign disease. Twenty-one of the 52 procedures had postoperative complications, a 40% complication rate. One postoperative death occurred from a myocardial infarction, for a 2% mortality rate. Infectious complications were the most common, occurring in 19% of cases. The one case of meningitis responded to antibiotic therapy, without neurologic sequelae. Seven cerebrospinal fluid leaks occurred (13%); five resolved with conservative management, and two required reoperation. There was no significant difference between complication rates for patients with previous craniotomy, radiation therapy, or chemotherapy compared with those with no prior therapy (p >.05). More complications occurred in patients with malignant disease than in those with benign disease (46% vs 27%), but this was not statistically significant (p >.05). Anterior and anterolateral skull base resection as part of a multidisciplinary approach to diseases of this region may provide improved palliation and may offer possible improved survival with acceptable surgical mortality. Although only 6% of patients were left with permanent neurologic sequelae in this series, the risks of serious complications are considerable. (*Skull Base Surgery*, 6(2):113–118, 1996)

The extension and modification of accepted otolaryngologic approaches to the orbit and paranasal sinuses, combined with an appropriate craniotomy, have provided important advances in the treatment of pathology at the anterior and anterolateral skull base. Because the barrier separating the sterile cranial vault from the aerodigestive tract is violated in these procedures, the potential for complications, especially infection and cerebrospinal fluid (CSF) leak, is considerable. Since the publication of Ketcham's first series in 1963,[1] complication rates have steadily fallen, as have mortality rates.[2-8] A review of recent series reveals overall complication rates from 39% to 50% and mortality rates from 3% to 5%.[3-8] Infectious complications have been the most common, occurring in 18% to 38% of patients, while CSF leak was the most common single complication reported.

A wide variety of pathology, both malignant and benign, may be addressed through an anterior combined skull base approach.[9-15] Successful treatment of pathology at the anterior skull base requires not only the coordinated care of the otolaryngologist and neurosurgeon, but appropriate efforts from plastic surgery, ophthalmology, radiology, radiation therapy, medical oncology, anesthesia, and rehabilitative care. The evolution of this multidisciplinary approach to anterior skull base disease contributes to the decreasing complication and mortality rates, as well as to the successful treatment and palliation of patients with a variety of pathologies.[3-8]

We report our experience with 52 combined anterior skull base procedures over a 6½ year period at our institution, with specific attention to the postoperative surgical complications associated with craniofacial resection for both malignant and benign disease.

MATERIALS AND METHODS

Forty-nine patients underwent anterior skull base surgery at the University of California, San Francisco Medical Center from November 1986 through August 1993. A total of 52 procedures were completed. Thirty-one patients were male and 19 patients were female. Patient ages ranged from 3 to 86. The average age was 43 years. Thirty-seven procedures were for malignant disease and 15 procedures were for benign disease. A wide variety of pathology was treated (see Table 1). Esthesioneuroblastoma, chondrosarcoma, and malignant meningioma were the most common malignant pathologies (four of each). CSF leak, occurring in five cases, was the most common benign indication for surgery.

Thirty-one patients had no previous therapy. Sixteen had preoperative radiation therapy, and nine patients had preoperative chemotherapy. Twelve patients had a craniotomy procedure prior to undergoing combined anterior skull base surgery.

All procedures involved a combined neurosurgical and otolaryngologic approach, and the senior otolaryngologist was the same for all procedures. A bifrontal craniotomy was the neurosurgical approach used in most cases, with a frontal orbito-zygomatic approach used when there was involvement of the postero-lateral orbital wall or the infer-medial middle fossa. A transsphenoethmoid approach, extended via a medial maxillectomy as needed, was the most common otolaryngologic exposure. Orbital exenteration was required in three cases. A pericranial flap was the most common method of skull base reconstruction, supplemented with fascia lata to augment dural repair, when necessary. Microvascular free tissue transfer, including rectus abdominus and latissimus dorsi free flaps, were used for larger defects in seven cases.

The medical records of these patients were reviewed for postoperative complications and deaths. Complication rates were calculated by the occurrence of one or more complications per anterior skull base procedure. Three patients underwent two combined anterior skull base operations, accounting for the 52 procedures among 49 patients. Reoperations for complications were not included in the total number of procedures. Postoperative mortality was similarly calculated. Complication rates for patient subsets were obtained in a similar manner and compared for statistical significance using the chi-square test.

RESULTS

Twenty-one of the 52 combined anterior skull base procedures had subsequent postoperative surgical complications for an overall complication rate of 40% (see Table 2). Seven patients had more than one complication. A total of 29 complications were noted. One postoperative death from a myocardial infarction occurred in an 81-year-old woman with recurrent basal cell carcinoma invading the skull base and orbits, for a mortality rate of 2%.

Infectious complications were the most common, occurring in 10 patients (19%). Seven epidural abscesses occurred and were treated with appropriate drainage and antibiotics. Subsequent osteomyelitis necessitating bone flap removal was noted in four cases (8%). One case of meningitis occurred (2%).

There were seven CSF leaks in this series, for an overall rate of 13%. Five resolved with conservative management including placement of a lumbar subarachnoid drain. Two patients required reoperation to augment dural repairs. Significant and persistent pneumocephalus manifesting as obtundation was noted in four cases (8%). Two resolved with conservative care and two required reoperation. One case of postoperative communicating hydrocephalus required shunting (2%). Three postoperative intracerebral retraction hematomas occurred (6%), requiring repeat craniotomy. Permanent neurologic sequelae resulted in two of three cases.

Seven patients underwent extensive skull base reconstructions using microvascular free tissue transfer.

Table 1.   Anterior Skull Base Pathology

Malignant	37
Esthesioneuroblastoma	4
Chondrosarcoma	4
Malignant meningioma	4
Squamous cell carcinoma	3
Adenocarcinoma	3
Neuroendocrine carcinoma	3
Undifferentiated carcinoma	3
Basal cell carcinoma	3
Fibrosarcoma	2
Other—mucosal melanoma, Wilms' tumor, rhabdomyosarcoma, neuroblastoma, mucoepidermoid ca., plasmacytoma, pituitary adeno ca., leimyosarcoma hemangiopericytoma	9

Benign	15
CSF Leak	5
Infectious	
Mucocele	2
Mucormycosis	1
Juvenile angiofibroma	2
Meningioma	2
Pleomorphic adenoma	1
Pituitary macroadenoma	1
Trigeminal schwannoma	1

Table 2. Complications

Type	Number	%
Infectious	10	19%
Epidural abscess	7	13%
Bone flap removal	4	8%
Cellulitis	2	4%
Meningitis	1	2%
CSF leak	7	13%
Pneumocephalus	4	8%
Intracerebral retraction hematoma	3	6%
Free flap related	3	6%
Hematoma	2	4%
Flap Failure	1	2%
Hydrocephalus	1	2%
Death	1	2%

Table 3. Complications by Prior Therapy and Pathology

	# Proc	# Comps	%
Overall	52	21	40
Preop chemotherapy	9	4	44
Preop XRT	16	6	38
Prior craniotomy	12	4	33
Benign pathology	15	4	27
Malignant pathology	37	17	46

Complications occurred in three patients with two hematomas at the anastomotic site requiring drainage and one flap failure necessitating another free flap procedure.

When the cases were subdivided by preoperative factors that might be suspected to affect postoperative complication rates, no statistically significant differences were noted (see Table 3). Patients were separated according to therapies received prior to their craniofacial procedure: chemotherapy, radiation therapy, or prior craniotomy. Four of nine patients who underwent preoperative chemotherapy had complications, for an overall rate of 44%. Six of 16 patients who had preoperative radiation therapy had complications, for a rate of 38%. Twelve patients had a previous craniotomy procedure prior to combined anterior skull base resection, four of which had complications, for a 33% complication rate. None of these individual complication rates differed significantly from the overall complication rate of 40% (chi-square test, p >.05).

Patients were then divided according to pathology. Four of 15 patients with benign pathology had complications, for an overall 27% complication rate. Of the 37 patients with malignant pathology, 17 patients had complications, for a 46% rate. This difference did not reach statistical significance (chi-square test, p >.05).

DISCUSSION

The most common indication for craniofacial resection is extension of paranasal sinus tumors into the cranial vault.[1-8] Although the majority of such processes are malignant, certain benign tumors may require aggressive surgical therapy.[15] Similarly, a combined anterior skull base approach may be required for the treatment of complicated infections and difficult CSF leaks. For any given indication, the potential resolution, cure, or palliation of the primary disease process must be balanced against the possible complications associated with such surgery and the inherent violation of the vital separation between the aerodigestive tract and the cranial vault. Several series have indicated that aggressive surgical therapy for certain malignant processes of the anterior skull base may pro-

vide sufficient palliation with adequate potential for cure to warrant craniofacial procedures.[3,4,6,7,11,14]

Various approaches to the skull base may be used to afford adequate exposure.[9,10,16,17] The requisite craniotomy usually consists of a bifrontal craniotomy extended into the temporal and sphenoid bones, as necessary. The orbital bones may be included to decrease brain retraction. Some authors prefer a mini-craniotomy, thinking complications may be reduced.[17] This may, however, sacrifice essential exposure. Our preference for transfacial exposure is the transsphenoethmoid approach with medial maxillectomy.[18] This may be expanded inferiorly or into the orbit, as necessary. The mid-facial degloving approach is another aesthetically favorable option.[19]

This series demonstrates the wide variety of pathology that may be addressed with craniofacial surgery (Fig. 1). All benign processes in this study were treated definitively; the most common benign, preoperative diagnosis was CSF leak. The remaining 37 procedures for malignancy addressed a variety of tumors. Sufficient long-term follow-up to allow meaningful conclusions regarding disease-free survival and the long-term therapeutic efficacy of craniofacial resection for specific malignant processes is not yet available. The focus of this series, at this time, is the specific complications which may be encountered after combined anterior skull base surgery.

The overall complication rate of 40% noted in this study is similar to other large published series.[3-8] As expected, infectious complications were the most common. These ranged from superficial cellulitis to epidural abscesses, of which there were seven. Therapy consisted of appropriate antibiotic coverage with abscess drainage. The further complication of bone flap osteomyelitis following epidural infection is serious and may require bone debridement or removal in 6% to 19% of cases as demonstrated by this study and other series.[3-8] Only one case of meningitis occurred in this series. It responded to antibiotic therapy. This rate of 2% compares favorably with other large series.[3-8] All patients in this series were treated perioperatively with broad-spectrum, intravenous antibiotics with excellent CSF penetration.

Cerebrospinal fluid leak was the next most common complication. Seven cases were noted, for a rate of 13%, which is similar to the 18% to 24% rates in other series.[5-8] Five of the cases resolved with conservative measures including bedrest, head elevation, and lumbar subarach-
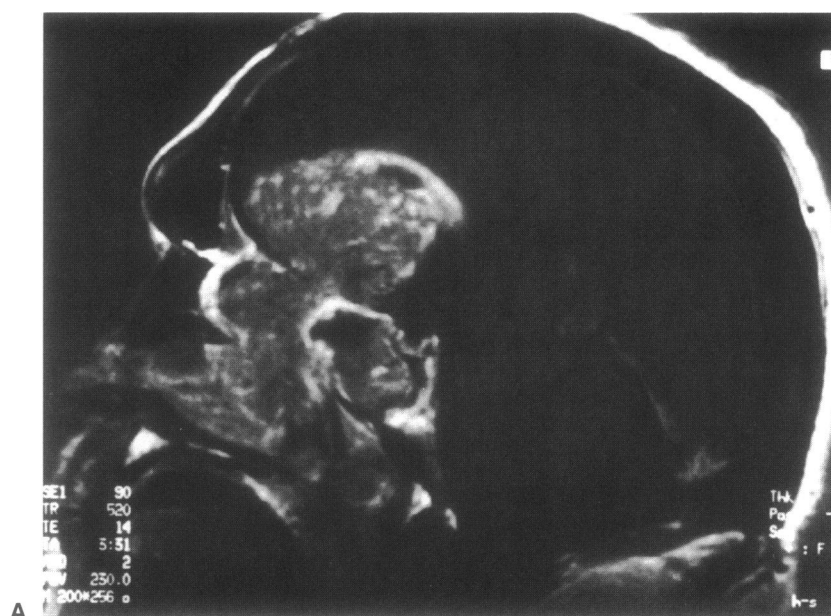
Figure 1. Sagittal (A) and coronal (B) T1-weighted MRI scans with gadolinium contrast demonstrating extensive paranasal sinus, orbital, and skull base involvement of a mucoepidermoid carcinoma in a 43-year-old man. This patient underwent complete resection with orbital exenteration and latissimus dorsi free flap reconstruction without postoperative complications.

noid drain placement for 3 to 5 days. Two cases required repeat craniotomy to reinforce dural repair with autologous fascia lata via repeat craniotomy. Similarly, two of the four cases of symptomatic pneumocephalus required augmented dural repairs (Fig. 2). The 8% pneumocephalus rate is similar to previously reported rates.[3-6]

The minimization of these complications requires a dependable and durable method of skull base reconstruction that can adequately maintain separation of the subdural space from the aerodigestive tract. Numerous options exist using local, distant, and vascularized free flaps.[20-23] When dura must be sacrificed during the resection, acceptable dural repair must be provided. Our primary reconstructive method is the pericranial flap. As demonstrated by this series and others, the pericranial flap is a versatile flap with excellent vascularity and no morbidity at harvest.[24-27] We have not found it necessary to skin graft the aerodigestive surface of this flap, as adequate mucosalization of the exposed flap occurs. For resections extending far posterior at the planum sphenoidale, and hence providing minimal bony shelf for flap support, we have used a longer flap and placed the distal

Figure 2. Axial CT scan demonstrating marked tension pneumocephalus in a patient after craniofacial resection for squamous cell carcinoma.

end into the posterior sphenoid sinus. This is supported from below by gauze packing under a layer of Gelfoam (Upjohn, Kalamazoo, MI), which is removed 10 days postoperatively. The flap is supported laterally by suturing it to the overlying dura from the planum forward to the margin of the frontal craniotomy. When further dural repair is required, free autologous fascia lata is our preference. Breakdown of this skull base repair required reoperation in two cases of persistent CSF leak and two cases of persistent pneumocephalus. The initial, conservative management of significant pneumocephalus consisted of raising the head of the bed to 30°, administering 100% O_2, clamping the lumbar drain, and percutaneous burr hole aspiration in severe cases.

For larger resections in which skull base deficits could not be repaired with the pericranial flap alone, microvascular free tissue transfer was used.[23] Rectus abdominus free flaps were used in five cases and latissimus dorsi free flaps in two. Three of these cases had subsequent complications related to the free flaps. One rectus flap failed after venous occlusion, could not be salvaged, and required replacement with a latissimus dorsi free flap. The other two complications consisted of hematomas drained at reoperation, without further recurrence. Free tissue transfer broadens the reconstructive options and therefore increases the possible extent of resection; however, inherent complications associated with free flaps, as well as prolonged operating time and possible anticoagulation, must be carefully considered.

Another serious and potentially morbid complication noted in this series is intracerebral retraction hema-

toma. Three such cases occurred and all required reoperation. Two of these cases resulted in permanent neurologic sequelae. The frontal lobe was involved in two cases, which likely resulted from prolonged retraction during the resection, emphasizing the importance of minimizing both the extent and duration of such retraction (Fig. 3). The remaining case occurred in the temporal lobe.

Many of the patients with malignant pathology had undergone previous therapeutic intervention. Analysis of patients grouped by prior chemotherapy, radiation therapy, or craniotomy demonstrated no statistically significant increase in complication rates compared with the overall complication rate in this study. This and other series indicate that such prior therapy is not a limiting factor from the standpoint of potential complications when planning surgical intervention.[4]

Although the difference in complication rate after craniofacial surgery for benign disease compared to malignant disease—27% to 45%, respectively—was not statistically significant, the sample size may have been too small to detect a significant difference. As the extent of resection required for benign disease is usually considerably less than that necessary for malignant disease, this trend, although not significant, is understandable and expected.

The single mortality in this series occurred from a myocardial infarction after extensive craniofacial resection and rectus free flap reconstruction for markedly symptomatic and multiply recurrent basal cell carcinoma in an 81-year-old woman who had undergone several prior resections, chemotherapy, and radiation therapy. Al-
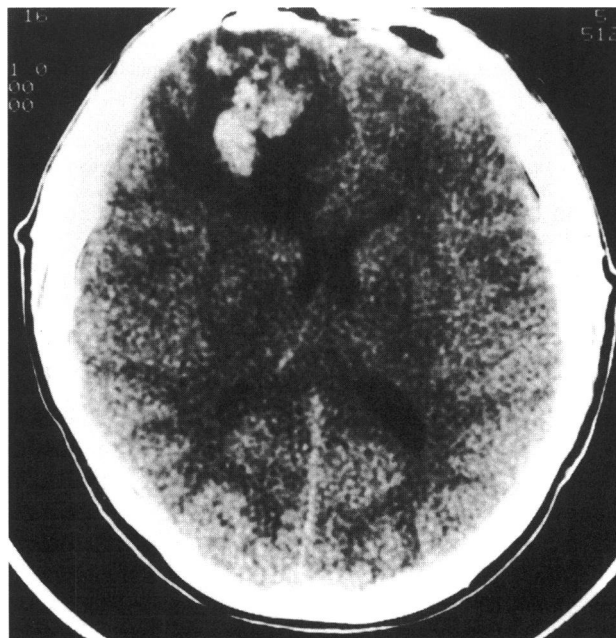

Figure 3. Axial CT scan demonstrating a frontal lobe intracerebral retraction hematoma which occurred after anterior craniofacial resection of an aggressive fibrosarcoma.

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though the 2% mortality rate compares well with recent series, the risk associated with such extensive surgery is exhibited.

CONCLUSION

The mortality and complication rates for craniofacial surgery have steadily decreased over the last 2 decades. Yet significant complications persist. A high index of suspicion, early recognition, and timely intervention are crucial to limiting potential morbidity. Our series is similar to the rates in other recent large series of overall complications and mortality. Fourteen complications required reoperation. Permanent sequelae were limited to one death and the two patients with neurologic sequelae after intracerebral retraction hematomas (6%). Infectious complications constitute the majority of craniofacial complications and require special attention. Meticulous skull base reconstruction separating the aerodigestive tract from the cranial vault is essential. Microvascular free flaps allow for larger resections and reconstruction, but may have an additional, inherent risk of complications. The decision to operate must be individualized and carefully discussed, and must balance the potential complications, as reviewed here, with the likelihood of palliation and potential cure.

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